Introduction

The purpose of this field guide is to provide information on nonindigenous (i.e., non-native) fishes that have been observed in Florida's marine waters. Introductions of non-native marine fishes into Florida's waters could be intentional or unintentional, and are likely from a variety of sources, including aquarium releases, escape from aquaculture, loss due to extreme weather events (e.g., flooding from hurricanes), and possibly transfer with ballast water or hull-fouling. Presently the lionfishes (*Pterois volitans* and *P. miles*) are the only non-native marine fish species known to be established along the coast of Florida. All other marine fishes in this guide (except the euryhaline species, see below) have infrequent occurrences, occur singly or in small groups, and have not yet become self-sustaining populations.

Aquarium releases are one of the major pathways whereby nonindigenous fishes gain access to new environments (Ruiz et al. 1997; Fuller et al. 1999). Most of the nonindigenous marine fishes found in Florida's waters are thought to be aquarium fishes that either were illegally released into the ocean or escaped captivity (e.g., during severe storm/flooding events). Indeed, south Florida is a hotspot for nonindigenous marine aquarium fishes (Semmens et al. 2004). Increased public awareness of the problems caused by released or escaped aquarium fishes may aid in stemming the frequency of releases. For example, Habitattitude™ (www.habitattitude.net) is a national public awareness and partnership campaign that encourages aquarists and water gardeners to prevent the release of unwanted aquarium plants, fish and other animals. It prompts hobbyists to adopt alternative actions when dealing with these aquatic plants and animals.

The invasion of Florida's marine waters by non-native fishes is in its early stages, especially compared to freshwaters of the state where dozens of fish species have become established. It is expected that new introductions will continue to occur, and it is possible that additional species could become established if no action is taken. To address this issue, NOAA's National Centers for Coastal Ocean Science (NCCOS), the Reef Environmental and Education Foundation (REEF), and the U.S. Geological Survey (USGS) have formed a partnership to focus on early detection and rapid response (i.e., removal) of non-native marine fishes. At this time, our efforts are focused on the southeastern coast of Florida, where many non-native fishes occur; however, it is our hope to expand this effort in time. Our goal in preparing this field guide was to synthesize identification information for the non-native marine fishes of Florida and to provide this information to the many collaborating state, federal, and local government agencies, universities, and non-profit organizations assisting in these

efforts. We hope this field guide will also be useful to a wider audience, including recreational divers and snorkelers, law enforcement and the interested public. Species in this guide could be considered to comprise a "watch list" of future potential invaders that might become established.

Herein, we provide information on 31 marine species and seven euryhaline species that are primarily freshwater, but can occasionally occur in brackish or marine waters. Of the euryhaline species that are included, five of the six cichlids (*Cichlasoma urophthalmus*, *Hemichromis letourneuxi*, *Oreochromis mossambicus, Sarotherodon melanotheron* and *Tilapia mariae*) and the poeciliid (*Belonesox belizanus*) are widely established in freshwaters of the state. The Nile tilapia (*O. niloticus*) is currently only known to be locally established (in Orange Lake, Alachua County), but could be more widespread in the State. We included these seven euryhaline species because they exhibit high tolerance to saline waters and are occasionally found in low-salinity habitats (e.g., seagrass beds, mangrove forests).

For more information on these species please visit the U.S. Geological Survey's Nonindigenous Aquatic Species (USGS-NAS) database (http://nas.er.usgs.gov). This website has been established as the national repository for spatially-referenced biogeographic accounts of nonindigenous aquatic species. It contains information on various taxa of aquatic non-native species from freshwater, brackish and marine environments, including invertebrates (e.g., mollusks, crustaceans, sponges, jellyfishes), fishes, amphibians, reptiles and mammals.

Methods

In this field guide we provide species accounts for non-native fishes from estuarine and marine waters of Florida. Species accounts consist of one or two photographs of the species, identification criteria, a summary of similar species that occur in Florida, native geographic range, non-native occurrences in the U.S.A., and a synthesis of the ecology of the species. References to source material are provided to those interested in learning more about the species. A map of occurrences in Florida is provided for each species. The species are arranged in approximate phylogenetic sequence. General discussions of the families precede the species accounts. Scientific names and authorities follow "A Catalog of the Species of Fishes" (Eschmeyer et al. 1998). To assist the reader, we have provided a world map delineating major marine regions (Fig. 1).

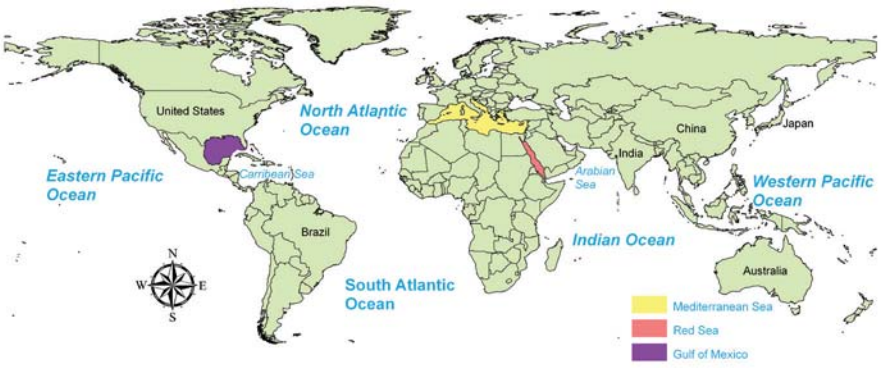

Figure 1. Major marine regions of the world

Meristics, Morphometrics and Species Identification

Meristics (the numbers of segments or body parts, such as scales or fin rays), morphometrics (the study of the shape or form of parts of the body), and body coloration are provided in each species account. One of the most commonly-used meristics is fin-ray counts, thus we have provided these when available. When fin-ray counts are reported, the first set of numbers in Roman numerals represents the number of spines, which are generally unbranched and stiffer than the rays. Soft rays occur on the dorsal and anal fins posterior to the spines, and are denoted in this text in parentheses with Arabic numerals directly after the spine count. Lengths are given as standard length (SL; distance from front of mouth to caudal peduncle) or total length (TL; distance from front of mouth to posterior end of caudal fin). To assist the reader with terminology used in the morphological descriptions of the species, we have provided line drawings (Fig. 2) denoting the major fins and body parts of fishes. For more information on meristics and morphometrics of a particular species, see the literature cited at the end of the “Identification” section of the species account.

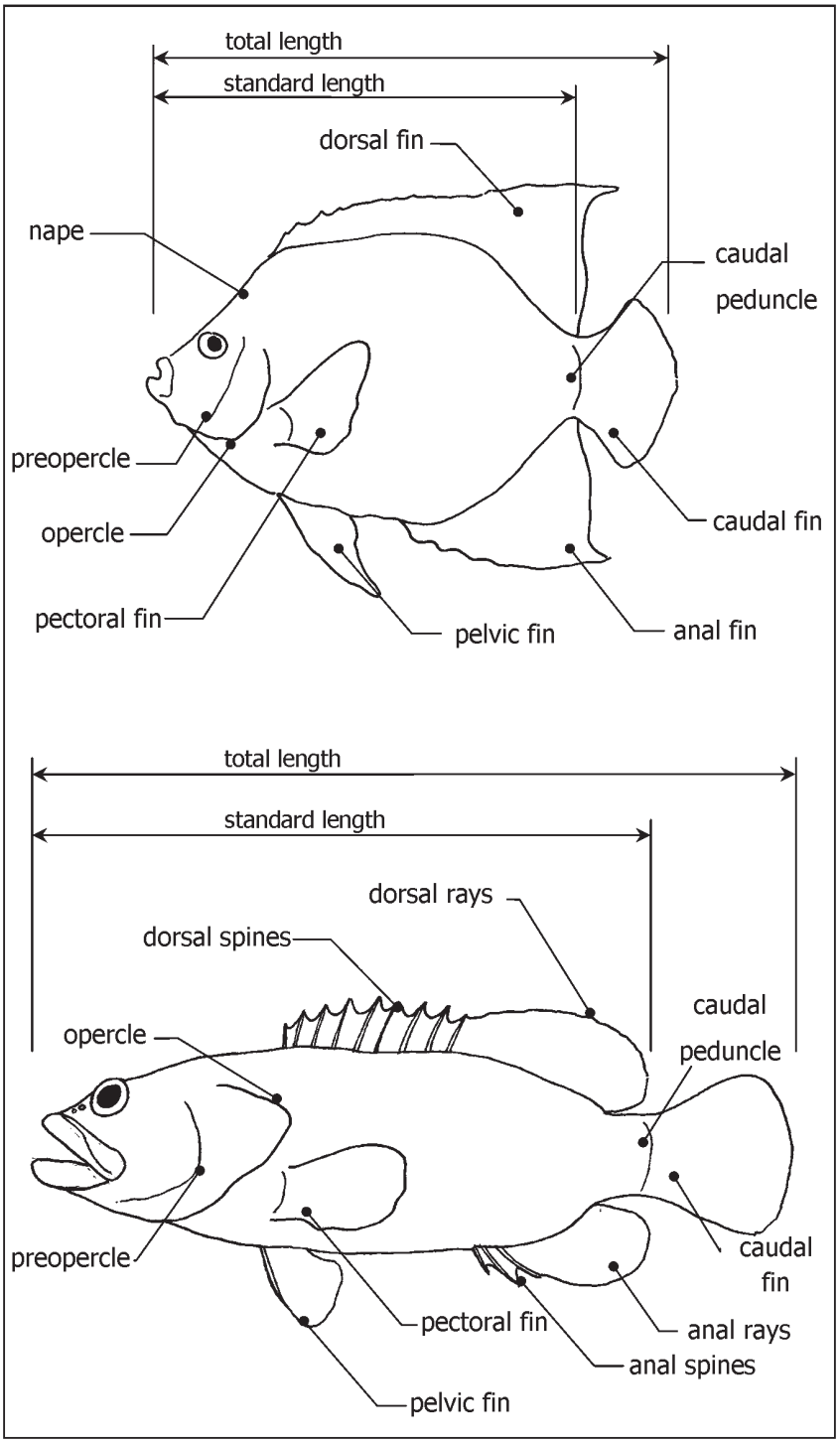

Figure 2. Line drawing showing fish fins and body parts.

Maps

The geographical occurrence of each species in Florida is given on a map within each species account. These maps are derived from records taken from the USGS-NAS database (http://nas.er.usgs.gov). Most of the occurrence data from the database have been mapped in point form; however, sometimes records with unspecific locations exist that cannot be mapped. When this is the case, we discuss the records in the "Nonindigenous Occurrences" section of the species account. For the euryhaline species that occur primarily in freshwater, but can also occur in brackish or marine waters, we use U.S. Geological Survey Hydrologic Unit Codes (HUCs) as a base to build the maps. This is a nationwide system that delineates watersheds based on surface hydrology (for more information, see: http://nas.er.usgs.gov/hucs.asp). Maps in this guide use 8-digit HUCs that are shaded in orange where the species is present.

Data used to create the maps were derived from the USGS-NAS database, which is comprised of multiple data sources including published literature, reports, other databases and personal communications. The Reef Environmental Education Foundation database (REEF 2008) and NOAA are major contributors of data to the USGS-NAS database. We have attempted to make the maps as current as possible; however, it is possible that we might not be informed of all occurrences of a species in Florida. Additionally, species distributions change over time; some more rapidly than others. Consequently, readers attempting to identify a specimen should not rule out a particular species because it has not been previously reported from the area. For the most current information on species distributions, visit the USGS-NAS database at http://nas.er.usgs.gov. The database is frequently updated as new records are added and earlier records are reviewed and corrected. Individuals who have relevant information concerning non-native fishes are encouraged to report their findings to state fish and game agencies and the USGS-NAS database.

Reporting discovery of non-native species

The collection or sighting of aquatic non-native species should be reported to the USGS-NAS database (http://nas.er.usgs.gov/sightingreport.asp). To report a new record, please provide photographs and the location where the species was sighted or collected as accurately as possible (including GPS coordinates, if possible).

Laws pertaining to non-native fishes in Florida marine waters

The Florida Fish and Wildlife Conservation Commission (FWC) regulates and manages Florida's fish and wildlife resources as authorized by Article IV, Section 9, of the Constitution of the State of Florida. ***The FWC prohibits the release of non-native fish and other aquatic organisms***

without a permit. Certain saltwater species are listed in Chapter 68-5, Non-Native Species, Florida Administrative Code (F.A.C.), as prohibited and may not be imported into the state, sold, possessed, or transported live. These species include mitten crab (*Eriocheir* spp.), sea snakes (Hydrophiidae), weeverfishes (Trachinidae) and stonefishes (*Synanceia* spp.). Prohibited species are considered to be dangerous to the ecology of the State and/or human health and welfare. These species cannot be personally possessed alive.

Non-native marine species that are not prohibited may be caught alive and personally possessed in private aquaria without a permit. However, once caught, they may not be released. The FWC allows the unrestricted take of these marine non-native species by legal methods. In order to catch non-native marine fish, a recreational fisher would need a recreational saltwater fishing license (unless marine life fishing is done by a Florida resident using cast nets or bait seines less than 100 feet in length and that have mesh that is 3/8 inch or less). Non-native marine fish may be taken by the following: rod and reel; hook and line; while free diving; by spearfishing except where prohibited; with landing or dip nets; with cast nets; with a bait, beach, or haul seine; or with blue crab or stone crab traps. There are certain methods of harvesting non-native marine fish that are strictly prohibited. These include gill or entangling nets, bangsticks and powerheads, diving by means of a rebreather, poisons, drugs or other chemicals unless permitted to do so.

These harvest/take regulations pertain only to marine waters within the jurisdiction of State of Florida (up to three geographic miles [3.45 statute miles] from the Florida coast into the Atlantic Ocean and nine leagues [10.376 statute miles] into the Gulf of Mexico). There are many other jurisdictions within the state that have separate rules that might differ from State rules. Some of these alternate jurisdictions include national parks, refuges, wildlife management areas, marine protected areas, and state parks. It is the responsibility of the fisher/diver to determine the jurisdiction and regulations before removing any marine life. For more information on Florida's regulations, visit http://myfwc.com/nonnatives/.

Acknowledgments

We thank the NOAA Aquatic Invasive Species Program for providing funding for this work. We are very grateful to the hundreds of individuals who provided data to the USGS-NAS, REEF, and NOAA databases. D. Gregoire, J. Langston, and M. Brown (USGS) provided expert technical assistance in the preparation of this field guide. C. Semmens (REEF) and P. Whitfield (NOAA) kindly facilitated data sharing with the USGS-NAS database. J. Randall (Bishop Museum), H. Jelks (USGS), L. Lovshin (Auburn University), J. Williams (Florida Museum of Natural History) and T. Rauch (William Carey University) kindly provided their excellent photographs. P. Fuller (USGS), W. Courtenay, D. Ahrenholz (NOAA-NMFS), T. Jackson (NOAA-NMFS), J. Hill (UF) and A. Benson (USGS) assisted in many aspects of this project.